

Development of a Compact-Sized Falling Needle Rheometer for Measurement of Flow Properties of Fresh Human Blood

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A compact-sized falling needle rheometer with quick operation and an automatic flow analysis has been developed for the viscometry of the fresh human blood without anticoagulant. The volume of fresh blood sample needed is only 3ml and the measuring time is within 2 minutes after taking a blood sample from the human body. Measured flow properties of human blood are evaluated as a flow curve, that is, the relationship between shear stress (τ) and shear rate ($\dot{\gamma}$). Observed flow curves of fresh human blood show the typical three fluid regions, that is, Casson fluid region for low shear rate range of $0 < \dot{\gamma} < 140 \text{ s}^{-1}$, the transition region for shear rate near $140 < \dot{\gamma} < 160 \text{ s}^{-1}$ and Newtonian fluid region for high shear rate range of $160 < \dot{\gamma} < 400 \text{ s}^{-1}$. Flow properties of a human blood such as a yield stress (τ_y) in the Casson fluid region and an apparent viscosity (μ) in the Newtonian fluid region are measured, and they are compared between male and female blood, respectively. It is found that the range of human blood viscosity for male is 5.5-6.4 mPa·s, and that for female is 4.5-5.3 mPa·s. The viscosities of male blood without anticoagulant show higher values than that of female. Human blood viscosities with anticoagulant show lower values than without anticoagulant. A linear relationship between the hematocrit value, that is the volume percentage of red corpuscles in human blood, and the apparent viscosity are observed both for male and female bloods. This paper concerns the flow analysis of fresh human blood viscosity without anticoagulant, using a newly-developed compact-sized falling needle rheometer.